Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Inquiry Regarding Carrier Current Systems	)	
Including Broadband Over Power Line Systems	)	ET Docket No. 03-104

COMMENTS OF THE NATIONAL ACADEMY OF SCIENCES' COMMITTEE ON RADIO FREQUENCIES

The National Academy of Sciences, through the National Research Council's Committee on Radio Frequencies (hereinafter, CORF)[1], hereby submits its comments in response to the Commission's April 28, 2003, Notice of Inquiry in the above-captioned docket (NOI). In these Comments, CORF discusses certain frequencies of importance to the Radio Astronomy Service (RAS) and urges the Commission to maintain, at the very least, the level of protection currently established for RAS observations in these bands.

I. Introduction: The Role of Radio Astronomy, the Unique Vulnerability of Passive Services to Interference, and the Importance of RAS Observations.

CORF has a substantial interest in this proceeding, as it represents the interests of the passive scientific users of the radio spectrum, including users of the RAS bands. RAS observers perform extremely important yet vulnerable research.

As the Commission has long recognized, radio astronomy is a vitally important tool used by scientists to study our universe. It was through the use of radio astronomy that scientists discovered the first planets outside the solar system, circling a distant pulsar. Measurements of radio spectral line emission have identified and characterized the birth sites of stars in our own galaxy, and the complex distribution and evolution of galaxies in the universe. Observations of supernovas have allowed us to witness the creation and distribution of heavy elements essential to the formation of planets like Earth, and of life itself.

The emissions that radio astronomers study are extremely weak--a typical radio telescope receives less than one-trillionth of a watt from even the strongest cosmic source. Because radio astronomy receivers are designed to pick up such remarkably weak signals, such facilities are therefore particularly vulnerable to interference from in-band emissions, spurious and out-of-band emissions from licensed and unlicensed users of neighboring bands, and transmissions that

[1] A roster of the committee is attached.

produce harmonic emissions that fall into the RAS bands.

In addition to the gains in scientific knowledge that result from radio astronomy, CORF notes that such research spawns technological developments that are of direct and tangible benefit to the public. For example, radio astronomy techniques have contributed significantly to major advances in the following areas:

- Computerized tomography (CAT scans) as well as other technologies for studying and creating images of tissue inside the human body;

- Increasing abilities to forecast earthquakes through the use of very-long-baseline interferometric (VLBI) measurements of fault motions; and

- Use of VLBI techniques in the development of wireless telephone geographic location technologies, which can be used in connection with the Commission's E911 requirements.

Continued development of new critical technologies arising from passive scientific observation of the spectrum requires that scientists have continued access to interference-free spectrum. More directly, the underlying science cannot be performed unless observers have access to interference-free spectrum. Loss of such access constitutes a loss for the scientific and cultural heritage of all people, as well as a loss of the practical applications coming from the knowledge gained and the technologies developed.

II. RAS Frequencies of Importance That Could Be Affected in This Proceeding.

Radio astronomers are particularly concerned about the potential for the generation of harmonics of the broadband radio signals, and of cross-products of these signals with other electrical waveforms. (See section III for further details.) Thus, frequencies at which radio astronomers make observations, up to a few hundred megahertz, could be impacted by emissions from the Broadband Power Line ("BPL") systems. The following is a list of frequencies that are subject to specific protections in the FCC rules that are relevant to this proceeding:

- 13.36-13.41 MHz, in which RAS has the sole domestic primary allocation,

- 25.55-25.67 MHz, in which RAS has the sole domestic primary allocation,

- 37.50-38.0 MHz, in which RAS has a secondary domestic allocation,

- 38.0-38.25 MHz, in which RAS has the sole domestic primary allocation,

- 73.0-74.60 MHz, in which RAS has the sole domestic primary allocation,

- 406.1-410.0 MHz, in which RAS has the sole domestic primary allocation, and

- 608-614 MHz, in which RAS has a co-primary domestic allocation.

In addition, the Commission's Table of Allocations lists International Footnote S5.149 which urges administrations to take all practicable steps to protect RAS observations at 150.05-153.0 MHz and 322.0-328.6 MHz from harmful interference. The latter band contains the hyperfine transition of the cosmologically important deuterium atom.

Observations in these bands are important for studying the interstellar medium, pulsars, and the Sun. Such observations are important for the study of thermal and non-thermal diffuse radiation in our own Milky Way galaxy, yielding information on high-energy cosmic-ray particles and their distribution, and also on the hot ionized plasma in our galaxy's disk.

The discovery and study of pulsars in the last two decades have opened up a major new chapter in the physics of highly condensed matter and the behavior of matter in high-intensity magnetic fields, contributing immensely to our understanding of the final stages of stellar evolution. Observations of binary pulsars by radio astronomers have verified the existence of gravitational radiation at the level predicted by the general theory of relativity.

Furthermore, important observations in these bands enable study of radio frequency outbursts from our Sun. These bursts of high-energy particles interact with Earth's atmosphere and can severely disrupt radio communications and power systems, as well as have dangerous effects on aircraft flights at altitudes above 15,000 meters. Study of these solar bursts aims to allow prediction of failures in radio communications. In addition, knowledge regarding high-energy solar bursts is essential for successful space exploration, both manned and unmanned.

III. The Commission's Current Protections of RAS Bands Should be Retained.

The Commission has long recognized the importance of protecting RAS observations in the aforementioned bands from the harmful effects of unlicensed emissions. Section 15.205(a) prohibits intentional transmissions by unlicensed devices in <u>each</u> of the above-listed bands allocated to RAS (with the exception of 406.1-410 MHz), as well as to the 322.0-328.6 MHz band that receives footnote protection. Section 15.209(a) provides specific limits on the spurious emissions that unlicensed devices may emit into these bands. Although more information concerning modulation technique, out of band signal strengths, and equipment maintenance is needed for a final evaluation of BPL's impact on other services, CORF believes that, at the very least, the level of protection currently provided under Part 15 for RAS observations must be retained. Removing or weakening these long-standing protections would significantly increase the likelihood of interference with RAS observations.

CORF believes that in evaluating the interference and out-of-band and spurious emissions, the Commission should be mindful of the impact of harmonics and other such mechanisms. The countless non-linear loads connected to the power-line transmission medium--power controllers, rectifiers, etc.--generate harmonics in the signal on the power line, even if the original data transmission system was totally without harmonic content. The transmission line inevitably radiates some of the fundamental signal, because (i) the dimension of the line (i.e., the wire separation) is an appreciable fraction of a wavelength, (ii) the current from the data transmission will inevitably not be perfectly balanced, and (iii) there are discontinuities along the line (transformers, etc.) that contribute to the degree of imbalance of data transmission currents in the line.

However, all of these negative conditions are magnified at higher frequencies, such as at the harmonics of the fundamental signal. For structures much smaller than a wavelength, the radiated power increases roughly as the square of the physical dimension measured in wavelengths, mainly as the spacing between the wires of the transmission line. So, although harmonics may be lower in amplitude, whatever harmonics exist will radiate much more efficiently than does the fundamental signal.

Besides harmonic radiation, other mechanisms that can generate signals beyond the intended signal frequency band include switching-type power supplies and other solid-state power controllers. Such equipment can generate signals, perhaps with a few megahertz bandwidth, that can mix with the high-frequency power line data signal, producing interference that falls well outside the intended power line data frequency range. Intermodulation products of the power line data signal itself, influenced by the many non-linear devices connected to the power line, will generate interference outside the original, intended frequency band as well.

CORF believes that unwanted radiation could be minimized by keeping the BPL system perfectly balanced, with equal currents flowing in each of the two conductors, and with close spacing between balanced conductors. A one-wire transmission system (as referenced in paragraph 20 of the NOI) would preclude such a solution and thus would be totally unacceptable. In a perfectly balanced system, most of the radiation comes from the connections to the transmission line. With a one-wire system, the entire length of conductor would radiate a significant fraction of the signal power being transmitted along the line.

BPL equipment will be placed mainly on telephone poles. CORF is further concerned about the long-term access to the equipment under Part 15. And, in addition to setting specifications on the equipment as purchased, a standard on the lifetime for the maintenance of such specifications may be needed.

IV. Conclusion.

Although more information concerning modulation technique, out of band signal strengths, and equipment maintenance is needed for a final evaluation of the impact of broadband over power line systems on other services, CORF is concerned about the possibility of out-of-band, spurious, and harmonic emissions into those bands allocated to RAS and discussed herein, especially from one-wire modulation techniques. CORF urges the Commission to maintain at the very least the level of protection currently provided under Part 15 for RAS observations in RAS bands. Removing or weakening these long-standing protections would significantly increase the likelihood of interference to RAS observations.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

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July 7, 2003

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